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TABLE OF CONTENTS

		Page
1.0	GENERAL DESCRIPTION	4
1.1	Subsystem Objectives	4
1.2	Purpose of This Document	5
1.3	Subsystem Functions	5
1.4	Applicable Documents	6
1.5	Documentation Tree	7
1.6	Definitions	8
2.0	SUBSYSTEM DESCRIPTION	9
2.1	Subsystem Capabilities	9
2.2	General Subsystem Characteristics	9
2.3	Subsystem Configurations	14
2.3.1	Single Channel Subsystem	14
2.3.2	Dual Simultaneous Channel Subsystem	14
2.4	Device Addressing	17
2.5	Subsystem Elements	17
2.5.1	Magnetic Tape Controller	17
2.5.1.1	Microprogrammed Peripheral Controller - MPC	17
2.5.1.2	Link Adapter - LA	18
2.5.1.3	Tape Controller Adapter-TCA	19
2.5.1.4	Device Switch - SW	19
2.5.2	Magnetic Tape Handler - MTH	19
2.6	Standards & Options	20
2.6.1	Controller Features	20
2.6.2	Handler Features	21
2.7	Interfaces	22
2.7.1	Peripheral Subsystem Interface - PSI	2222
2.7.2	Internal Adapter Interface - IAI	22
2.7.3	Device Level Interface - DLI	23
3.0	SOFTWARE CONSIDERATIONS	23
3.1	Status Returns	23
3.1.1	Termination Status	23
3.1.2	Special Status	25

		Page
3.2	Software Status	25
3.3	T&D Command Considerations	26
4.0	RECORDING TECHNIQUES	27
4.1	Recording Formats	27
4.1.1	NRZI Record Formats	27
4.1.2	PE Record Formats	28
4.2	Data Integrity	29
4.2.1	NRZI Data Integrity	29
4.2.2	PE Data Integrity	30
5.0	RELIABILITY AND MAINTAINABILITY	31
5.1	Reliability	31
5.1.1	Controller Reliability	31
5.1.2	Handler Reliability	31
5.2	Maintainability	31
5.2.1	Controller Maintainability	31
5.2.2	Handler Maintainability	32
6.0	GENERAL DESIGN REQUIREMENTS	34
6.1	Packaging Requirements	34
6.1.1	Controller Packaging	34
6.1.2	Controller Dimensions	34
6.1.3	Handler Packaging	34
6.1.4	Handler Dimensions	34
6.2	Power Requirements	34
6.2.1	Controller Power Requirements	34
6.2.2	Handler Power Requirements	35
6.3	Cooling Requirements	35
6.3.1	Controller Cooling	35
6.4	Environmental Requirements	35

1.0 GENERAL DESCRIPTION

This document specifies the requirements for a magnetic tape subsystem intended for use on 6000 series systems. This subsystem will control the writing on and reading from magnetic tape recorded in either the NRZI or PE modes. Both seven track and nine track tape handlers will be accommodated in this subsystem. The basic units of this subsystem are the Microprogrammed Peripheral Controller (MPC), Link Adapter (LA), Tape Controller Adapter (TCA), Device Switch (SW), and Magnetic Tape Handler (MTH).

1.1 Subsystem Objectives

The objectives of this subsystem include:

- Provide single channel and dual simultaneous channel operation.
- Provide field upgrade from single channel to dual simultaneous channel configuration, with increases in number of handlers to the maximum capability of the subsystem.
- Provide a high degree of subsystem modularity.
- Provide on-line diagnosis, and off-line repair.
- Provide 1600 bpi phase encoding (PE) as well as 200, 556, 880 bpi non-return to zero, change on ones (NRZI).
- Operate on systems with a peripheral subsystem interface (PSI) channel on an input/output multiplexer (IOM), or on systems providing an equivalent interface discipline.
- Control the magnetic tape units by microprograms residing in the microprogrammed peripheral controller (MPC).
- Maintain error statistics related to data transfers.
- Include both 7 track and 9 track handlers.
- Operate simultaneously with multiple external user systems (EUS's).

1.2 Purpose of This Document

The purpose of this document is to define in general terms the hardware and software requirements which must be met so that this subsystem will function properly on the 6000 Series systems. This document is at the subsystem level, and therefore is broad in scope. Details of the hardware and software designs and operations will be found in other documents.

1.3 Subsystem Functions

In the broad sense,the subsystem functions include the following:

- Permit single-and-dual simultaneous channel operations.
- Read/write/erase tape; load/unload/rewind tape.
- Accept commands from IOM, interpret and respond to commands, transfer data to and from storage media, generate and transmit status to IOM.
- Generate and read media compatible with industry standards.

1.4 APPLICABLE DOCUMENTS

EPS-1 Microprogrammed Peripheral Controller (MPC), 43A177875

EPS-1 Link Adaptor (LA), 43A177879

EPS-1 Peripheral Subsystem Interface (PSI), 43A177784

EPS-1 IOM Peripheral Subsystem Interface Adapter, 43A177880

EPS-1 Input/Output Multiplexer (IOM) Central, 43A219604

EPS-1 Magnetic Tape Handler, MTH500 Series 59A502064

General Design Requirements for GE-655 System, 43A177851

Common MPC Maintainability, 43A237500

NPL Device Level Interface (DLI) for Magnetic Tape Subsystem, BL0024

Area Objectives for New Products Line (NPL) Micro-programmed Peripheral Controller (MPC) Subsystems BL0021

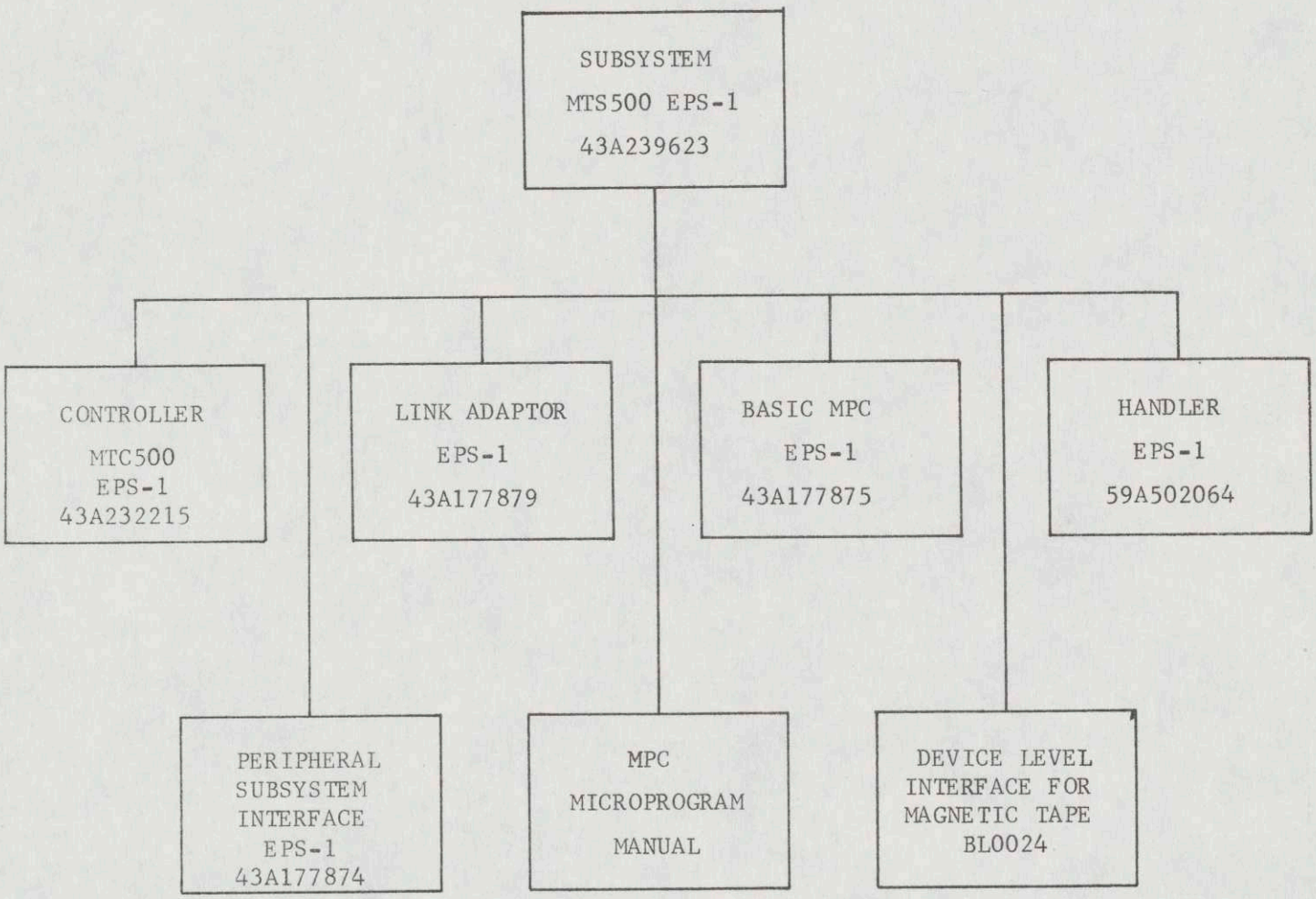
X3B1/403 - April, 1970, Draft USA Standard - Unrecorded Magnetic Tape for Information Interchange

X3B1/425 - April, 1970, USA Standard - Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI)

X3B1/426 - April, 1970, USA Standard - Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)

X3B1/400 - April, 1970, Proposed USA Standard - Recorded Magnetic Tape for Information Interchange (1600 CPI, Phase Encoded)

1.5 DOCUMENTATION TREE



1.6 DEFINITIONS

MPC	Microprogrammed Peripheral Controller
IOM	Input/Output Multiplexor
TCA	Tape Controller Adaptor
LA	Link Adaptor
MTH	Magnetic Tape Handler
EUS	External User System refers to the central system which is making use of the magnetic tape subsystem
PSI	Peripheral Subsystem Interface
IAI	Internal Adaptor Interface
DLI	Magnetic Tape Handler Device Level Interface
ips	Tape velocity at the MTH head in inches per second
bpi	Bits Per Inch. Data recording density when considered longitudinally along tape. Corresponds to character per inch in NRZI recording, and to bytes per inch in PE recording.
PE	Phase Encoded
NRZI	Non-Return to Zero, change on ones.
frame	A set of bits when considered laterally across the tape. A frame in 7-channel tape has up to 7 bits; a frame in 9-channel has up to 9 bits.
byte	As used in this specification, a byte is a group of 8 bits which are considered as a unit.
character	A group of 6 bits considered as a unit.
controller	This is the unit consisting of MPC, LA(s), TCA(s) and SW.
LCC	Longitudinal Check Character
CCC	Cyclic Check Character
ITR	Integrated Test Routine

2.0 SUBSYSTEM DESCRIPTION

2.1 SUBSYSTEM CAPABILITIES

This subsystem will control the movement of, recording, on, and reading from ½ inch magnetic tape. The tape may be either seven track or nine track, and may be formatted in either the PE mode (for nine track) or NRZI mode (for seven or nine track). The tape may be moved at velocities of 75 ips, 125 ips and 200 ips, and the data packing may be 200 bpi, 556 bpi or 800 bpi NRZI, or 1600 bpi PE. The resulting nominal data transfer rates range from 11.25 K-bytes/sec. (15 K-char/sec) to 320 K-bytes/sec. (426.6 K-char/sec).

Both single channel and dual simultaneous data transfer operations are available, with up to sixteen magnetic tape handlers in the subsystem.

Special features include switched channels to the external user system, and optional 9 track code translation including ASCII to BCD (internal 6000 6-bit code), EBCDIC to BCD, and EBCDIC to ASCII. Dependent on the density code set in the handler, the code translation may be written on tape in either NRZI or PE modes.

The capabilities of this subsystem are summarized in Figures 2.1.1, 2.1.2 and 2.1.3.

2.2 GENERAL SUBSYSTEM CHARACTERISTICS

This subsystem will incorporate some features which are new to the 6000 line. This section summarizes the extent of these features.

- The controller will not contain any operator switches. Therefore, the modification of handler address formerly accomplished by configuration switches on magnetic tape controllers will not be possible. Also, new set density commands will replace the over-ride switches on the former Set High and Set Low commands.

Speed / Density	75 ips	125 ips	200 ips
200 bpi	* 15K (200K)	25K (33.3K)	40K (53.3K)
556 bpi	41.7K (55.6K)	69.5K (92.6K)	111.2K (148.26K)
800 bpi	60K (80K)	100K (133.3k)	160K (213.3K)
1600 bpi	120K (160K)	200K (266.6K)	320K (426.6K)

FIGURE 2.1.1

Data Rates for Various Recording Densities and Handler Speeds for 9-Track Handlers

* The data rates are given as bytes/sec (character/sec), with K = 1000.

Speed / Density	75 ips	125 ips	200 ips
200 bpi	* 11.25K (15K)	18.75K (25K)	30K (40K)
556 bpi	31.275K (41.7K)	52.125K (69.5K)	83.4K (111.2K)
800 bpi	45K (60K)	75K (100k)	120K (160K)

FIGURE 2.1.2

Data Rates for Various Recording Densities and Handler Speeds for 7-Track Handlers

* The data reats are given as bytes/sec (char./sec), with K = 1000.

Internal 6000 Format \ Handler Format	7 Track	9 Track
6000 Code (6-bit)	none	EBCDIC
6000 Code (6-bit)	none	ASCII (7-bit)
ASCII (7-bit)	none	EBCDIC

FIGURE 2.1.3

Optional Code Translation in Subsystem

2.2 GENERAL SUBSYSTEM CHARACTERISTICS (continued)

- o While the initial offering will include only the MTH-502 and MTH-505 handlers, it is anticipated that 7-track and 200 ips handlers will be included. Therefore, this subsystem is specified to include these handlers.

- o The controller will contain four forms of code translation, three of which are optional.

  - . BCD - Same as in previous 600 line subsystems. Not an option.

  - . 6-bit to/from EBCDIC - conversion between 6000 line 6-bit format to/from 8-bit EBCDIC on tape. Optional feature.

  - . 6-bit to/from ASCII - conversion between 6000 line 6-bit format to/from 8-bit ASCII-7 on tape. Optional feature.

  - . ASCII to/from EBCDIC - conversion between ASCII-7 characters in 6000 to/from EBCDIC bytes on tape. Optional feature.

- o Special Interrupt - When a special interrupt is sent from the controller to an external user system, information will be included to define the interrupting device and reason for the interrupt.

- o This subsystem is capable of being shared by independent external user systems. This is possible because of such features as the ability for the independent EUS's to communicate via the subsystem, and for these independent EUS's to selectively reserve any handler connected to the subsystem.

- o The subsystem will perform automatic retries for read-type command errors which have a Device Data Alert major status. This feature may be inhibited by the EUS.

- o The subsystem will maintain an error log for specified errors occurring within the subsystem.

2.3 SUBSYSTEM CONFIGURATIONS

The permissible configurations for single channel and dual simultaneous channel subsystems are summarized in the following sections.

2.3.1 Single Channel Subsystem

As shown in Figure 2.3.1, a single channel subsystem may contain from one to eight magnetic tape handlers connected to the controller via a radial switch. The total control unit including LA, MPC, TCA, and SW will be housed in a single cabinet.

The LA will contain a non-simultaneous switch so that two PSI channels may be connected to the controller.

The 1 x 8 switch will be modular so that one module will accommodate four tape handlers; a second SW module is added to connect from five to eight handlers to the controller.

The single channel subsystem may be field upgraded to a dual simultaneous channel subsystem by the addition of a second LA, a second TCA and appropriate switch modules.

2.3.2 Dual Simultaneous Channel Subsystem

The dual simultaneous channel subsystem is illustrated in Figure 2.3.2, which shows that up to sixteen magnetic tape handlers may be connected to the controller via a radial switch. This controller, containing two LA's, one MPC, two TCA's, and a 2 x 16 switch are packaged in a single cabinet. The LA's are the same as those used in the single channel controller. The 2 x 16 switch is modular so that each module will connect to four tape handlers. As handlers are added to this subsystem during a field upgrade, additional switch modules are added to the controller as required.

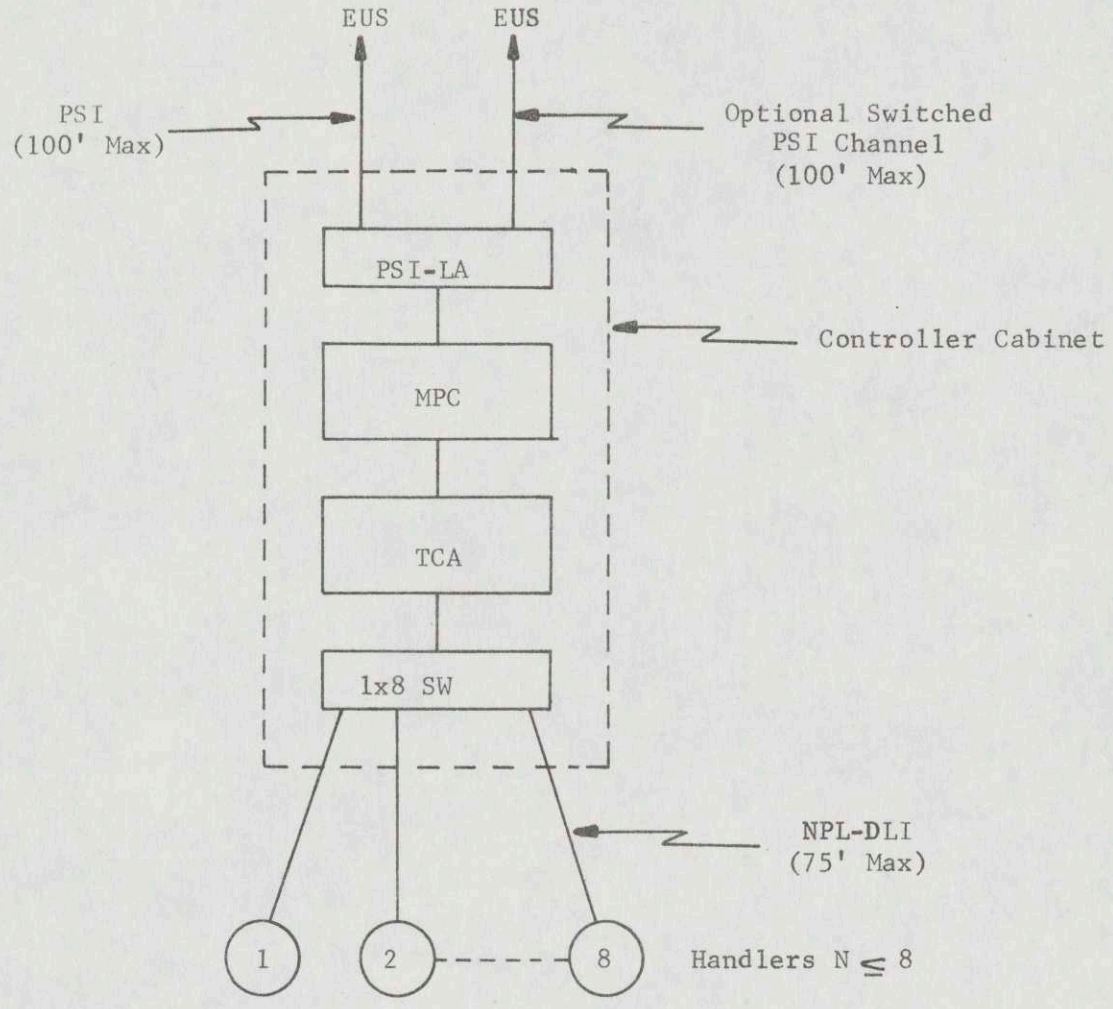


FIGURE 2.3.1

SINGLE CHANNEL SUBSYSTEM

SHOWING MAJOR FUNCTIONAL UNITS

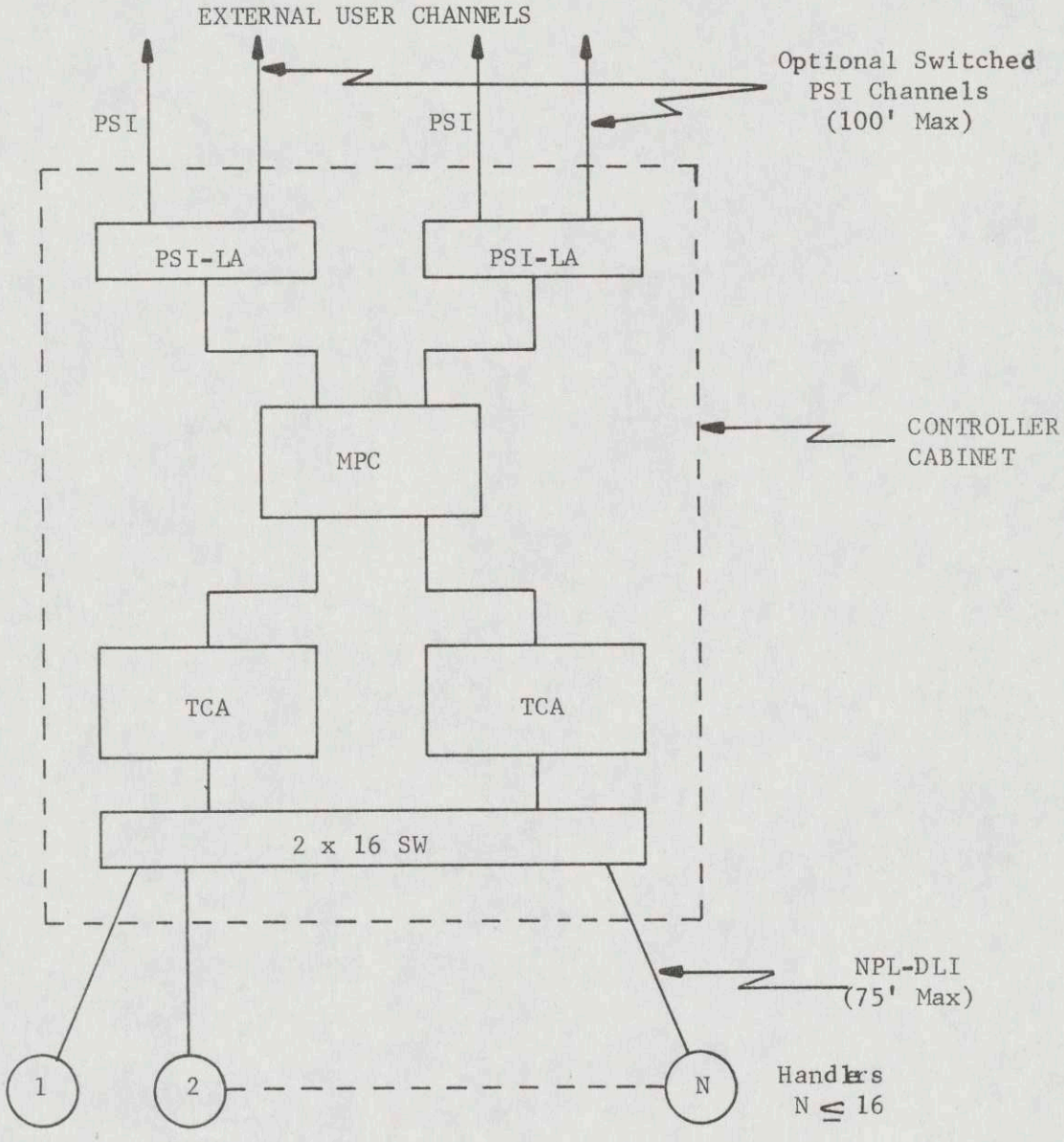


FIGURE 2.3.2

DUAL-SIMULTANEOUS CHANNELS
SUBSYSTEM SHOWING MAJOR FUNCTIONAL UNITS

2.4 DEVICE ADDRESSING

The controller in this subsystem shall be identified as device zero, and the handlers shall be numbered starting with number one. Thus, the handler numbers in a single-channel subsystem range between one and eight, and in a dual-channel subsystem the handler numbers range between one and sixteen.

Each device will contain a five-bit code wired into the handler when the handler is installed in the subsystem. This number, and the number on the front of the handler cabinet which is visible to the operator, must be made the same. These numbers are unique within the subsystem, and will not be changed for the duration of the life of the handler on that subsystem. Since the visible number corresponds to the device code, the wired-in number also corresponds to the device code. The controller must maintain a table relating device codes to device switch ports. This table must be dynamic so that it is updated whenever a handler is added to or removed from the subsystem.

2.5 SUBSYSTEM ELEMENTS

The functions of the significant subsystem elements are discussed in the following sections.

2.5.1 Magnetic Tape Controller

The controller comprises three functional entities which, when combined together, provide the control mechanism for the tape handlers. These three entities are the MPC, LA and TCA.

2.5.1.1 Microprogrammed Peripheral Controller - MPC

The MPC is a general purpose, register-to-register micro-instruction processor. Its basic elements are a Control Store, Read/Write Memory and a Processing Structure. By means of microinstructions which reside in the control store, the MPC can be microprogrammed to manipulate data between registers within the MPC, between registers and local MPC Read/Write Memory, between registers and Link Adaptors, and between registers and Tape Controller Adaptors. Communication between the MPC and TCA/LA is via the Internal Adaptor Interface.

2.5.1.1 Microprogrammed Peripheral Controller (continued)

Control Store: The storage medium which is used to contain the microinstruction routines in the Basic MPC. May or may not be implemented in read/write technology. However, the MPC accesses Control Store on a read-only basis.

Read/Write Memory: The storage medium which contains control information of a non-permanent nature.

Processing Structure: The Processing Structure provides the control, register storage and logical/arithmetic capability required to access, decode and execute microinstructions which reside in either Read-Only Store or in Read/Write Memory.

Internal Adaptor Interface: The interface by which the Basic MPC interfaces with Tape Controller/Link Adaptors.

The basic MPC firmware functions include the following:

- Interpret commands received by the LA from the EUS.
- Control dialog on PSI and IAI.
- Gather MTH, TCA, MPC status, format and transmit to EUS via LA.
- EOF generation/detection.
- Record and file gap control.
- LCC/CCC gap control.
- Write time base generation.
- Blank character time base generation.
- BOT PE Identification burst detection.
- Accumulate error status information.

2.5.1.2 Link Adaptor - LA

The LA is a hardware communication module with the necessary logical and storage capabilities to connect the MPC to the PSI. The LA is controlled by the MPC firmware via the IAI.

2.5.1.3 Tape Controller Adaptor - TCA

The controller adaptor contains device oriented electronics and logic functions supplementing the capabilities of the MPC. The TCA contains the data recovery logic for phase encoded data (the data recovery logic for NRZI is in the tape handler), as well as those functions not readily controlled by the MPC firmware. These functions include:

- o LCC generation
- o CCC generation
- o PE/NRZI error detection/correction
- o Data buffering
- o Code translation
- o Pack/unpack associated with code translation
- o Generation of TCA status
- o PE preamble/postamble generation/detection
- o BOT PE Identification Burst generation

2.5.1.4 Device Switch - SW

The device switch provides a radial communication link between the TCA and the tape handlers. This provides the capability of removing any handler from the controller without disconnecting any other handler.

2.5.2 Magnetic Tape Handler - MTH

The magnetic tape handler provides the transport mechanism, and associated read/write electronics, necessary to generate and read tape. Additional functions of the handler include:

- o NRZI data recovery
- o Move tape forward/reverse
- o Rewind/unload/load tape in off-line mode (off-line to EUS, but controller may retrieve handler status).
- o Maintain handler status, and transmit to controller upon request.
- o Provide required control logic for tape movement

2.5.2 Magnetic Tape Handler - MTH (continued)

- Generate D-C Power for handler electronics.
- Provide automatic load/unload capability.
- Condition signals for transmission to MTC.
- Provide extensive diagnostic capability to MTC.

Although the handler has the capability of reading tape in the reverse direction, the external user system will not accept data read in the reverse mode.

2.6 STANDARDS AND OPTIONS

The features of the handlers and controllers are described in the next two sections.

2.6.1 Controller Features

	MTC501	MTC502
Simultaneous data transfer	No	Yes
Maximum No. Handlers	8	16
Recording Densities		
200,556,800 bpi NRZI	Yes	Yes
1600 bpi PE	Yes	Yes
No. Tracks	7 & 9	7 & 9
Standard Code Translation		
BCD	Yes	Yes
Optional Code Translation		
6-bit to/from EBCDIC	Yes	Yes
6-bit to/from ASCII	Yes	Yes
ASCII to/from EBCDIC	Yes	Yes
Device Switch Modularity		
No. handlers per module	4	4
Read Reverse Capability	No	No
Multi-System External Users	Yes	Yes

2.6.2 Handler Features

	MTH502	MTH505
No. Tracks	9	9
Speed Forward (ips)	75	125
Rewind Speed (ips)	500	500
Reverse Speed - Backspace (ips)	75	125
Recording Densities		
200,556,800 bpi NRZI	Yes	Yes
1600 bpi PE	Yes	Yes
Automatic Load	Yes	Yes
Power Window	Yes	Yes
Options		
7-track, 200, 256, 800 bpi NRZI	Yes	Yes
or		
9-track, 1600 bpi PE only	Yes	Yes
Canister Load - Factory install	Yes	Yes
Canister Load - Field Upgrade	Yes	Yes
High Altitude Blower - factory install	Yes	Yes
High Altitude Blower - Field upgrade	Yes	Yes
D.C. Power Meter	Yes	Yes
Tape Movement Meter	Yes	Yes
ANSI Capatible Recording (per reference specifications listed in Section 1.4)	Yes	Yes
Start Time	5 msec	3 msec
Stop Time	5 msec	3 msec

2.7 INTERFACES

The various interfaces within the magnetic tape subsystem are illustrated in Figure 2.7. The characteristics of these interfaces are summarized in the following sections.

2.7.1 Peripheral Subsystem Interface - PSI

The PSI is characterized as:

- A discipline defining the connection of external user systems to peripheral subsystem.
- A family of interfaces with varying byte width, although the magnetic tape subsystem will use the one byte version.
- A discipline in which the MPC is the master of the dialog on the PSI.
- As implemented on the 6000 series systems, the PSI may contain one, two, four, or eight logical channels per physical PSI channel. However, the recommended configuration for the magnetic tape subsystems is two logical channels per physical PSI channel.

2.7.2 Internal Adapter Interface - IAI

The IAI is an interface which:

- Exists internal to the MPC in the form of a backpanel connection.
- Is a discipline interfacing the MPC to LA's and TCA's.
- Contains a two byte data path, which may be operated in the single byte mode.
- Operations on the IAI are controller by the MPC firmware.

2.7.3 Device Level Interface - DLI

This interface defines the dialog and interface circuitry involved in the transfer of information between controller (i.e., the switch) and the tape handler. This is characterized as:

- o Radial interface with single independent cable from each device to the switch in the controller.
- o All-digital interface.
- o Optimized for PE operation which means that PE deskew is located in the TCA, and NRZI deskew is located in the handler.
- o Provides a mechanism for transferring detailed handler status to the controller.

3.0 SOFTWARE CONSIDERATIONS

3.1 STATUS RETURNS

Two types of status returns will be provided the external user system by the controller -- termination status and special interrupt status. These two status types will provide some features which are unique to the controllers implemented with an MPC using the PSI.

3.1.1 Termination Status

It is intended that the termination status returned to the external user system by these subsystems shall be a superset of the CPI interface termination status available to the external user system in 600/6000 series systems. The extensions to the termination status shall be the result of the subsystem containing additional capabilities to determine fault modes, log data errors, etc. The extension to the termination status shall appear as new substatus for existing major status, and as new substatus under new major status. The status word will be formatted the same as for existing termination status in the 600/6000 series systems.

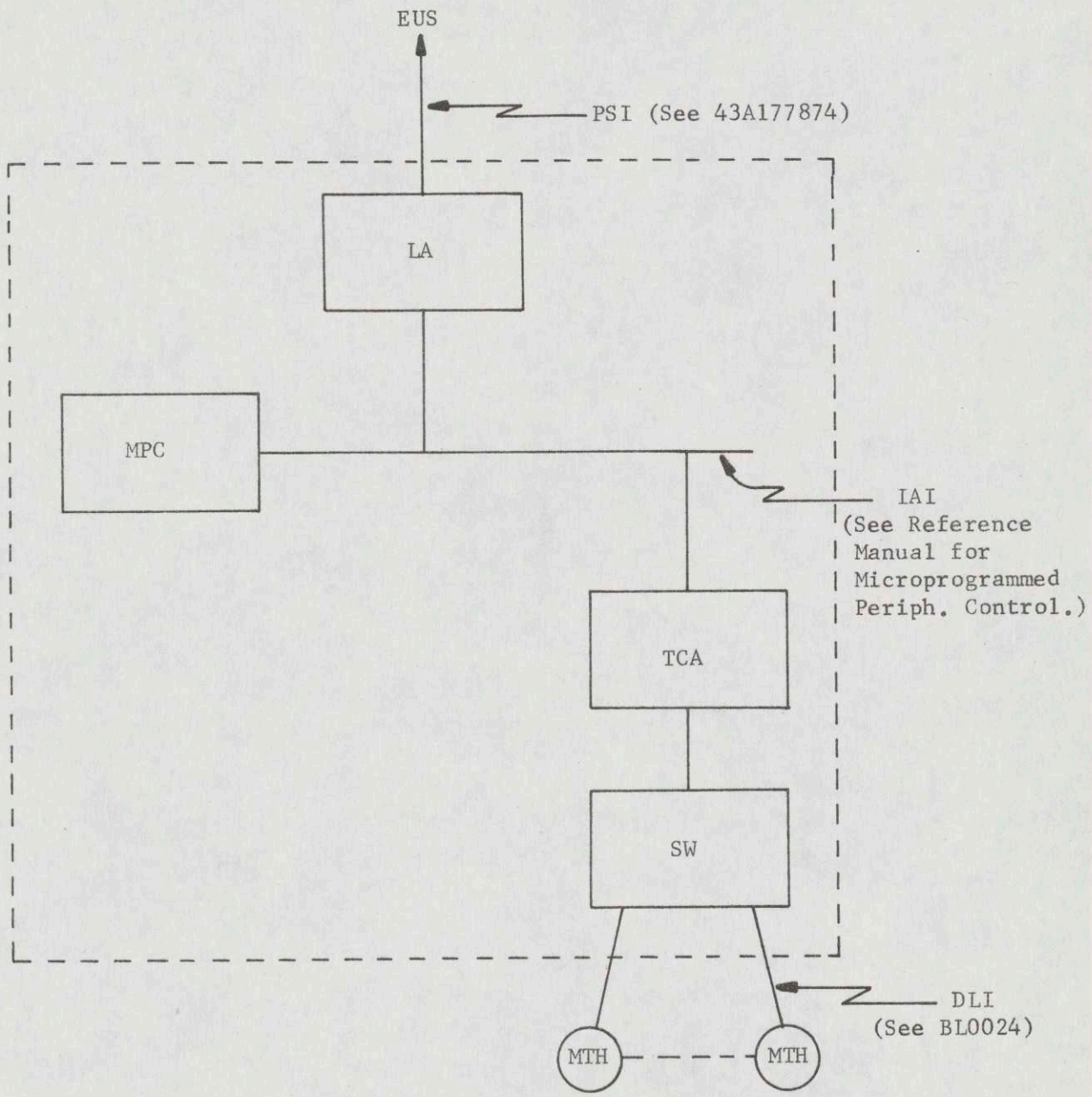


FIGURE 2.7

SUBSYSTEM INTERFACES

3.1.2 Special Status

These subsystems will have the capability of transmitting special status to the external user system in a form which will identify the device causing the special status interrupt and will indicate the reason the device is causing this status. This will be used for such interrupts as rewind complete and a device coming to the on-line state from the off-line state.

3.2 SOFTWARE STATUS

The instruction set for these subsystems shall be a superset of the command set available on current 600/6000 series systems. The extensions shall occur in areas related to performance improvement, physical restrictions of the controller and/or handler, and T&D capabilities. The T&D commands are discussed in Section 3.3, and the command extensions primarily for software are discussed below.

- The concept of Set Low and Set High commands, working in conjunction with switches mounted on either a controller or handlers, will be replaced with discrete commands to set the addressed handler to a specific density. Commands will be required to set the addressed handler to 200, 556, 800 or 1600 bpi. These commands will be selected such that the Set 556 bpi command uses the same op-code as the former Set Low command, and the Set 800 bpi command uses the same op-code as the former Set High command. Two new op-codes will be required for the Set 200 bpi and Set 1600 bpi commands.

- The subsystem will perform code translations when writing data on tape, and when reading data from tape, under the direction of the appropriate commands (See Section 2.6.1 for summary of optional code translations). Commands will be specified to direct the controller to perform the necessary code translations.

- New commands will be specified so that the software may reserve/release handlers in a dual operating system environment.

- A command discipline, working in conjunction with the read/write memory portion of the controller, will provide a mechanism for communication between two independent operating systems utilizing a common subsystem.

3.2 SOFTWARE STATUS (continued)

- Commands will be provided which permit the software to survey all devices attached to the controller, and obtain general characteristics of each handler. Included in these characteristics will be such items as handler speed, recording capability, number of tracks, and ready status.

- The Addressing of devices in these subsystems will be such that the controller is device number zero, with the addresses of the handlers starting at device number one.

- Capability will be provided so that the software may turn off the subsystem automatic retry of read type data errors.

3.3 T&D COMMAND CONSIDERATIONS

Commands will be provided so that the T&D software will have extended capability in testing and diagnosing faults in the subsystem. These commands include techniques to load, read, and test various memories in the MPC, and test and read status from the handlers.

- A portion of the control store of the MPC will be available to test routines for the test and fault isolation of the basic MPC logic. Commands will be provided so that test overlays may be loaded into the writeable portion of the control store to provide extended testing of the controller adaptor. In addition, commands will be provided so that the tape controller firmware may be loaded from the external user system into the control store.

- Commands will be provided so that the external user systems may load handler commands (i.e., DLI commands) directly to the addressed handler. Further, commands will be provided to test the timing of the handler capstan motor, and to test the data paths in the handler by exercising various wrap around paths in the handler.

- The capability will exist so that the controller read/write memory may be loaded directly from the external user system. One application of this capability may be the reading of error logs maintained by the controller.

4.0 RECORDING TECHNIQUES

The MTS500 subsystems will be capable of reading and writing data in two basic formats -- NRZI and PE. The NRZI format will be utilized at densities of 200, 556 and 800 bpi; the PE format will be used at 1600 bpi. The general recording techniques of each basic format, and the data integrity checks for each, are discussed in the following sections. Details of these recording techniques may be found in the standard documents listed in Section 1.4, and in the MTC500 EPS-1.

4.1 RECORDING FORMATS

4.1.1 NRZI Record Formats

In NRZI (Figure 4.1) or "non-return to zero, change on ones", a fluz transition occurs on tape for each ONE bit, with no flux transition for the ZERO bit. Data formats are arranged so that at least one flux transition takes place on one of the 7 or 9 parallel tracks for every bit cell. Thus, a clock is provided without assigning a separate clock track.

A long string of ZERO's results in a lack of flux transitions, while a string with many ONE's will result in flux transitions at a repetition rate directly related to the ONE bits and the tape speed. Thus, many fundamental frequency components are recorded on the data tracks, depending upon the various combinations of ONE's and ZERO's. These varying flux transition rates require that the head and read amplifiers be designed to accommodate a wide range of frequencies.

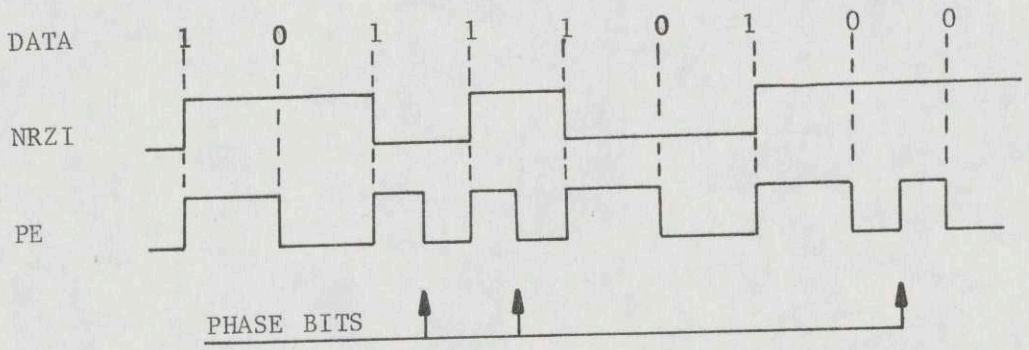


FIGURE 4.1

RECORDING TECHNIQUES

4.1.1 NRZI Record Formats (continued)

The record formats for NRZI records varies with the number of tracks recorded, and with the density. These are summarized as follows:

- All 7 track recording will be inthe NRZI mode. Each record will contain a longitudinal check character (LCC) of the data in the record. Each data frame will contain a parity bit. During the writing of the record, the data is read after being written and is returned to the controller where a parity check is performed on the data frames (called the read-after-write check).

- Data records for nine track may be written in the NRZI mode. If the recording is at 200 or 556 bpi, the record will contain an LCC check, as well as odd parity with each data frame written on tape.

- If the nine track recording is at 800 bpi, the data record will contain odd parity with each frame, an LCC frame, plus a cyclic redundancy check (CRC) frame.

- The standard file marks for seven track and nine track handlers will be octal 17 and octal 23 respectively. Unique file marks may be written by software if desired by using the write type commands with a single character record.

4.1.2 PE Record Formats

In order to overcome the deficiencies of NRZI recording discussed above, another saturation recording technique combines the clock and data to provide at least one flux transition for each bit cell, and thus achieves self-clocking on a single track.

It would seem (Figure 4.1) that NRZI recording would be superior to "phase encoding" (PE) for maximum packing density, since fewer flux changes are required per bit cell and the fundamental frequencies are lower. However, certain compensating factors make PE recording more reliable than NRZI for high-bit packing densities.

4.1.2 PE Record Formats (continued)

Only two fundamental frequencies are present in PE recording: the frequency f for zero and 2f for one. With NRZI recording the frequency spectrum is much greater because a string of zeros can result in an output signal approaching dc, while a string of ones will result in a high frequency signal dependent upon tape speed. The narrower bandwidth achieved in PE recording results in improved signal-to-noise ratio. Narrow bandwidth also permits head response to be tailored for maximum output at the two frequencies, and steep wavefronts with sharp zero crossings are obtained. These are more easily detected, and reduced susceptibility to drop-outs results from the system's ability to tolerate considerable reduction in signal level before decoding becomes impossible.

The PE recording technique results in almost double the packing density at the same bit accuracy when compared to NRZI recording.

The record format for PE records is limited to one type, with the exception of the file mark record. This recording mode is summarized as follows:

- Limited to 1600 bpi on nine track handlers.
- Each record contains a preamble, the data area, and a postamble. The preamble and postamble are invisible to the external user system.
- Each data frame will contain an odd parity bit.
- The file marks are specialized records not containing the preamble or postamble, but containing a unique format distinguishable to the controller as a file mark record. The standard file mark record shall contain a representation for an octal 23. The external user system may generate a file mark with some other character by using a write type command with a single character transfer.

4.2 DATA INTEGRITY

4.2.1 NRZI Data Integrity

The data integrity features for the NRZI recording modes include the following:

- Each data frame written on tape will contain a parity bit which is attached to the frame before it leaves the controller, and is then checked by the controller with the read-after-write process. This parity bit is odd for nine track handlers, and may be odd or even for seven track handlers depending on the data format (odd parity for binary data; even parity for BCD data).

4.2.1 NRZI Data Integrity (continued)

- The controller performs a read-after-write check on the data frames as they are written on the tape to verify that the frame parity is correct.

- Each data record shall contain an LCC frame, which is the mod 2 sum of the bits in the corresponding track. This LCC is generated by the controller, and is checked during the read commands.

- For 800 bpi records on nine track tape a CRC frame is appended to the record. This provides a measure of correction ability if during the reading of a record the errors are restricted to a single track. The controller then rereads the record in error, using the saved CRC information to correct the bits in error.

4.2.2 PE Data Integrity

The data integrity features of PE recording include:

- Each frame written on tape contains an odd parity bit.

- The controller performs a read-after-write check of the parity of each frame as it is written on tape.

- By the nature of PE recording, the controller will be able to perform in-flight error correction during the read commands if the errors are such that a single error occurs in each frame. Also, when the errors occur in separate tracks, the frames containing errors must be separated by the data recovery buffer capacity for effective error correction. The external user system will not be aware that this correction has taken place, although the controller will log the fact that it occurred.

5.0 RELIABILITY AND MAINTAINABILITY

5.1 RELIABILITY

The reliability goals for the controller and the handlers are discussed in the following sections. The reliability criteria are summarized in Figure 5.1 for various subsystem configurations.

5.1.1 Controller Reliability

Since the magnetic tape subsystems are applications of the MPC, the reliability of the basic control mechanism (basic MPC) and the link adaptors is determined by the components utilized in their design. However, the controller adaptor is designed specifically for the magnetic tape controller application, and therefore must be designed with components selected from standard NPL components or from standard PCO components.

5.1.2 Handler Reliability

The handlers in these subsystems are designed for NPL systems, and therefore must utilize NPL components wherever possible. Refer to Performance Specification, Magnetic Tape Handlers NTH500 Series (59A502064) for handler reliability criteria.

5.2 MAINTAINABILITY

To ensure a minimum down time as the result of device faults, both the controller and handler must be designed such that the diagnosis and repair of faults is readily accomplished.

5.2.1 Controller Maintainability

The maintainability criteria for these controllers is defined in common MPC Maintainability Specification, 43A237500. In addition, particular requirements are placed on the magnetic tape controllers as follows:

- The basic MPC logic and memories, and the tape controller adaptor, will be tested by isolation test routines (ITR's) to isolate and catagorize hardware faults. A fault dictionary will be provided to indicate the component(s) requiring replacement/repair.

5.2.1 Controller Maintainability (continued)

- Design criteria will be established which will provide the designers with guidelines in implementing the required functions. These will include requirements on flip-flop initialization, ITR visibility of registers, and logic partitioning.

5.2.2 Handler Maintainability

The electro-mechanical and device oriented electronic failures will be covered by functional T&D programs executed from the external user system under the control of either OPTS-600 or MONITOR II. In general, these programs shall use the normal magnetic tape firmware.

Tests of the handler will include testing of marginal or stress conditions as necessary to detect high probability failure modes or maladjustments.

The handler design will include extensive status register information (available to the external user via a special command) including:

- power supply margins
- high temperature sensing
- capstan margin control indication
- vacuum monitoring
- data wrap around
- logic states

	SINGLE CHANNEL		DUAL CHANNEL			
	4 MTH	8 MTH	4 MTH	8 MTH	12 MTH	16 MTH
EXPECTED MEAN TIME BETWEEN CONTROLLER FAILURES/HOURS **	5205	4988	3627	3520	3419	3324
EXPECTED MEAN TIME BETWEEN MTH FAILURES/ HOURS	500	250	500	250	167	125
EXPECTED MEAN TIME BETWEEN SUBSYSTEM FAILURES/HOURS	456	238(4850)*	439	233	159	121(3270)*

* Number in parenthesis is for the case where one handler is considered as a spare.

** Hours refers to power-on hours.

FIGURE 5.1

RELIABILITY OF SUBSYSTEM

6.0 GENERAL DESIGN REQUIREMENTS

6.1 PACKAGING REQUIREMENTS

6.1.1 Controller Packaging

The magnetic tape controller shall be packaged to conform with the requirements of 43A177851. The LA, MPC and TCA shall be packaged as a single control unit such that the cabling between each module is held to the minimum practical.

Wherever possible, standard NPL components, or standard PCO components, shall be used in the implementation of this controller.

6.1.2 Controller Dimensions

The height and depth profiles of the control unit shall not exceed any of the following:

width	55 inches
depth	27½ inches
height	38 inches

6.1.3 Handler Packaging

The handler shall be constructed so that the electronics and electro-mechanical components are functionally partitioned where practical. The control electronics shall be mounted on replaceable PWB's, with the power supplied from a supply mounted within the handler. Wherever practical, NPL components shall be utilized in the design of the handler.

6.1.4 Handler Dimensions

The handler dimensions shall not exceed any of the following:

width	30 inches
depth	29 inches
height	61.5 inches (65.3 inches to top of operator panel)

6.2 POWER REQUIREMENTS

6.2.1 Controller Power Requirements

The A-C power requirements for the controller shall conform to General Design Requirements (43A177851), paragraph 4.1.3, titled AC Power for Peripherals.

6.2.2 Handler Power Requirements

The A-C power requirements for the handlers shall conform to General Design Requirements (43A177851), paragraph 4.1.3.

6.3 COOLING REQUIREMENTS

6.3.1 Controller Cooling

The anticipated cooling requirements for the controller are as follows:

MTC501	2900 BTU/hr.
MTC502	4040 BTU/hr.

6.4 ENVIRONMENTAL REQUIREMENTS

The components of this subsystem shall meet the environmental guidelines of specification B01.08.

MTS-500 SUBSYSTEM
SPECIFICATION

SIGNATURE SHEET

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